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Geological notes and local details for 1:10000 sheets NZ05NW, NE, SW and SE

Edmondbyers and Hedley on the Hill

Part of 1:50000 sheet 20 (Newcastle upon Tyne)

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PREFACE

The area covered by National Grid square NZ 05 lies in the south-western portion of the country shown on 1:50 000 geological sheet 20 (Newcastle upon Tyne), and falls within a section of that sheet which has been surveyed as part of a contract between the Department of the Environment and the Institute of Geological Sciences.

Mapping was carried out between 1977 and 1981 by Messrs E.A. Edmonds, J.R. Davies and D.A.C. Mills, under the supervision of Mr. J.G.O. Smart and Dr. D.B. Smith as District Geologists.

The Department of the Environment is supplied with a geological map, relevant overlays and a report for each 1:10 000 sheet covered by the contract. The report that follows was written by Messrs E.A. Edmonds and J.R. Davies.

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Fig. 1 Sketch map showing main localities

Fig. 2 Distribution of Namurian and Westphalian strata

Fig. 3 Generalised vertical section of the solid rocks

Fig. 4 Sketch map showing distribution of sand and gravel,
worked out opencast coal areas and principal buried
valleys

See also geological maps and overlays

GEOLOGY OF THE COUNTRY BETWEEN EDMONDBYERS AND HEDLEY ON THE HILL
(NATIONAL GRID SQUARE NZ 05)

INTRODUCTION

The area represented by 1:25 000 sheet NZ 05 extends from Healey and Hedley on the Hill in the north to Edmondbyers and Consett in the south (Fig. 1). Minsteracres lies just within its western margin and Ebchester immediately beyond its eastern. The whole is underlain by Carboniferous rocks of Namurian and Westphalian age (Fig. 2), mostly obscured by a mantle of glacial drift which is generally less than 5 m thick but in places fills deep buried valleys.

Within the 'solid' succession the Quarterburn (Gastrioceras subcrenatum) Marine Band is taken to mark the Namurian (Millstone Grit Series) - Westphalian (Coal Measures) junction and the Harvey (Anthracoeras vanderbecki) Marine Band the junction between Westphalian A (Lower Coal Measures) and Westphalian B (Middle Coal Measures) (Fig. 3). The main mappable rock type is sandstone. Principal coal seams, limestones and marine bands are also delineated, and the intervening shales, mudstones, seatearths and thin sandstones are shown as 'undivided'. Thick, massive sandstones are typical of the upper Namurian and lowermost Westphalian successions. They form prominent topographic features, readily discernible even where coated with drift. Smaller features, attributable to sandstones elsewhere in the succession, are common, and the main mapping technique within this area of generally poor exposure is the delineation of ridges and scarps marking sandstones, and 'slacks' and depressions eroded in predominantly argillaceous rocks.

Superficial deposits comprise widespread boulder clay or till, mainly stony clay with subordinate silt, sand and laminated clay in places, and patches of glacial sand and gravel clearly defined at Edmondbyers and Muggleswick and west and north-west of Ebchester but largely indistinguishable from sandy boulder clay around Hindley.

Because of a very gentle easterly regional dip, workable coals occur mainly in the east of the area. Much mining has taken place, but underground working is currently confined to a small private mine in Westriding Wood, near Hedley on the Hill. Small-scale subsidence has produced locally irregular ground surfaces and ill-drained hollows which interrupt a broad pattern of dairy and arable farming on the sandier soils and dairying and stock-rearing

on the heavier clays. Two large areas, south of Whittonstall and at Greymare Hill, and several smaller ones, have been worked out for opencast coal and the land restored to farming. Such a process removes the problems associated with localised subsidence. West of the Stocksfield Burn, sandy rocks mainly of early Westphalian age are overlain by thin acid sandy peaty soils supporting much commercial forestry.

The southern part of the area is traversed by tunnels which form part of the Kielder Water Scheme. The Letch House - Derwent Tunnel extends south from Greymare Hill, via a headpond reservoir at Airy Holm [047 539]¹, to emerge north of the River Derwent [0427 5145]. The Derwent - Wear Tunnel starts immediately south of the River Derwent [0405 5077] and extends beyond the southern limits of the area. Detailed information on the geology encountered during the construction of these tunnels, of site investigation boreholes, and of the geotechnical properties of the various strata involved is available from the site investigation reports of Babbie Shaw and Morton, IGS records and TRRL Supplementary Report 676.

NAMURIAN ROCKS

The characteristic feature of the Namurian rocks is the presence of thick grit sequences.

Edmondbyers and Muggleswick. Grits and interbedded argillaceous strata north of Edmondbyers and west of Muggleswick form bold escarpments. Exposure is poor, and most of the detailed information available is based on records of boreholes and tunnel sections. One of the Derwent Dam boreholes [0229 5089] proved the following low Namurian sequence:

Surface c. + 230 m A.O.D.

Drift and weathered sandstone	to 7.77 m
Shale, grey to brown, sandy at base	" 14.10 m
Grindstone Sill: sandstone, brown-grey, massive to cross-bedded	" 21.34 m
Shale, grey, sandy, micaceous	" 23.32 m
Sandstone, greyish brown, argillaceous, massive	" 24.54 m
Shale, grey, with fine-grained sandstone laminae, some slumps	" 33.53 m
Shale, dark grey	" 39.01 m
Upper Felltop Limestone (?): grey, massive and sandy towards base, lowest part dark grey and crinoidal	" 41.68 m

¹National Grid Reference within the 100 km square NZ

Seatearth-sandstone, brown, argillaceous to 42.37 m
 Sandstone, white, fine-grained, cross-bedded

to base of hole at 42.67 m

Disused quarries, as at Berrybank [0130 5065] and Bale Hill [0030 5345], show coarse-grained, cross-bedded, feldspathic sandstones which give rise to marked features. The high fells west of Edmondbyers are underlain by topmost Namurian sandstones, with outliers of Westphalian rocks forming local prominences such as Turfhole Hill [000 505].

Barelaw Hill. On the northern side of the Derwent Reservoir a sequence similar to that around Edmondbyers is much obscured by drift, and topographical features are less well defined. Disused quarries north of Cronkley [0175 5290] and near Birkenside [0307 5235], Carterway Heads [0475 5182] and Fine House [0470 5310] are all in sandstones, medium- to coarse-grained, flaggy or cross bedded and locally pebbly and feldspathic. Argillaceous rocks are exposed at Calfclose Hole [0390 5230], where black fissile shales, 3 m, are overlain by blocky grey silty shales, 2 m, capped by flaggy sandstone, 0.5 m. The same black shales, in a disused quarry [0350 5222], have yielded fish fragments. Disused adits nearby mark the position of a thin impersistent coal in these argillaceous measures.

The high ridges around Moor Game [0285 5385] and to the north-east of Manor House [0445 5250] are capped by sandstones close to the top of the Namurian sequence.

Shotleyfield Burn. An isolated section through the Quarterburn Marine Band and the highest Namurian strata occurs in Shotleyfield Burn upstream from Hammermill Bridge [0649 5299]:

	m
Quarterburn Marine Band [0624 5310]:	
Mudstone, blue-grey, fissile, with shell debris	0.36
Ironstone nodule band, fossiliferous, with abundant bivalves and a few brachiopods	0.03
Mudstone, blue-grey, with <u>Lingula</u>	0.31
Ironstone nodule band	0.03
Mudstone, blue-grey, silty, fissile, with <u>Lingula</u>	0.33
Sandstone post, green-grey, fine- to medium-grained, argillaceous and micaceous laminae, abundant <u>Zoophycus</u> , rare <u>Lingula</u>	0.10

	m
Seatearth-mudstone, pale grey, silty, with listric surfaces	0.60
Siltstone, pale grey, argillaceous, flaggy	0.70
Mudstone, grey, silty	1.25
Sandstone post, dark blue, micaceous, very hard, with <u>Zoophycus</u> on upper surface	0.15
Seatearth-mudstone, pale grey, clayey towards top, silty towards base	0.60
Mudstone, grey, silty, with impersistent siltstone and fine-grained sandstone beds	0.52
Sandstone, white to orange, medium-grained, flaggy to cross-bedded, micaceous, soft and clayey towards top; exposed to bridge	5.00

Consett and Shotley Bridge. The River Derwent and its tributaries in the vicinity of Shotley Bridge and Consett provide numerous sections through top Namurian and bottom Westphalian strata.

Mere Burn flows east to join the River Derwent south of Ebchester at [0937 5498]. It traverses the following easterly dipping succession:

	m
Quarterburn Marine Band [0887 5485]: sandstone post, green-grey, medium-grained, argillaceous and micaceous laminae, abundant <u>Zoophycus</u> , highly fossiliferous ferruginous nodules	0.20
Seatearth-mudstone, pale grey, silty, gradational base	0.15
Seatearth-sandstone, pale brown, fine-grained, micaceous, becoming coarser and more strongly cemented towards base	1.00
Sandstone, pale brown, medium- to coarse-grained, micaceous, flaggy to cross-bedded, exposed to confluence with River Derwent at [0937 5498]	25.00

Seatearth-mudstones overlying flaggy sandstones in Snow's Green Burn downstream from Snow's Greenburn Bridge [0921 5341] are thought to equate with the seatearths below the Quarterburn Marine Band seen in Mere Burn. The inferred position of the marine band is immediately below the bridge.

Posts of hard, dark blue-green sandstone with the trace fossil Zoophycus are seen in sporadic exposures in Burnhouse Gill downstream from Shotley Bridge Road [0768 5290]. They resemble the Zoophycus post of Mere Burn and

Shotleyfield Burn and are accordingly thought to lie close to the Quarterburn Marine Band. Underlying coarse-grained, cross-bedded feldspathic sandstones are exposed in the stream bed [0808 5276] immediately upstream of a fault that brings these Namurian rocks into contact with low Westphalian strata. The same high Namurian beds probably occur beneath the drift in the lower reaches of Burnhouse Gill.

For about 0.5 km south of Shotley Bridge [0907 5275] the River Derwent flows through a steep-sided ravine incised into the thick sandstone which underlies the Quarterburn Marine Band. The sides of the gorge are up to 15 m high. The sandstone is medium to coarse grained, micaceous, flaggy to cross bedded and locally pebbly and feldspathic. Impersistent beds of silty shale also occur.

Wallishwalls Burn enters the River Derwent north of Allensford Bridge [0769 5024] and the following composite section has been recorded:

	m
Sandstone, brown to white, medium- to coarse-grained cross-bedded, conglomeratic towards base	4.00
Siltstone, green-grey, argillaceous, micaceous, eroded top	0.95
Sandstone, pale brown to white, medium- to coarse-grained, massive, flaggy and cross-bedded, conglomeratic towards base	12.00
Mudstones, dark grey, silty, with thin beds of fine- grained sandstone, eroded top	3.25
Sandstone, green-yellow, coarse-grained	1.25
Mudstone, dark grey, silty	1.85
Sandstone, pale brown, medium-grained, cross-bedded; exposed in river bed	0.75

Healey area. Healey Burn, downstream from [0007 5858], runs on thin sandstones and shales. Low cliffs alongside the burn show up to 6 m of the overlying medium- to coarse-grained, thick-bedded to massive, current-bedded feldspathic sandstone. Shales immediately below this sandstone, a few metres west of the area, have yielded fossils indicating the presence of a marine band. Strata above the sandstone, sporadically exposed in the twin headwaters of the burn, comprise about 5 m of shales, mudstones and silty shales with seatearths and ferruginous nodules, and with a thin coal seam near the top of the sequence;

they are presumed, from evidence to the west of the area, to contain the Quarterburn Marine Band.

Shales, locally nodular, with mudstones and thin sandstones, crop out [0086 5668 to 0088 5656] in Healey East Burn south of the Ninety Fathom Fault. Their position relative to the inferred crop of the Ganister Clay to the south suggests that they may contain the Quarterburn Marine Band.

Fairley may Gill. Fairley may Gill flows into Stocksfield Burn near Bridges Farm, just south of the Ninety Fathom Fault. The section is as follows:

	m
Sandstone, brown, medium-grained	5.0
Shales, grey, rubbly, fossiliferous (presumed Quarterburn Marine Band) [0441 5723], on shales, seatearths and thin sandstones; thickness uncertain	? 10.0
Sandstone, brown, medium- to coarse-grained, current-bedded, massive	10.0
Shale, grey, fossiliferous [0447 5746]	0.6
Seatearth, brownish grey	0.3
The lower fossiliferous shale may be equated with the marine band recorded in Healey Burn and above the Whitehouse Limestone in Stocksfield Burn.	

Stocksfield Burn. The valley of the Stocksfield Burn, between Wheelbirks Cottages and Hindley Bridge, and the lower reaches of the tributary Lynn Burn, traverse a shallow dome showing the following succession:

	m
Sandstone, brown, medium-grained, current-bedded; massive and thickly bedded below, finer grained and thinner bedded above	10.0
Shale, grey, sandy, micaceous	1.0
Coal, soft, bright	0.2
Shale, dark grey, carbonaceous	0.1
Seatearth, brown, sandy	0.4
Shales, grey, with thin sandstones	1.0
Sandstone, greyish brown, fine-grained, blocky, with plant fragments	1.0
Shale, grey	0.3
Sandstone, greyish brown, fine-grained	0.5
Shales, grey, with thin sandstones	3.0

	m
Shale, blue-grey, micaceous, with ironstone nodules and penetrated by adit [0534 5958]	1.0
Seatearth, ferruginous	1.5
Sandstone, greyish brown, fine-grained, knobbly, with roots and abundant <u>Zoophycus</u>	1.0
(Quarterburn Marine Band presumed hereabouts)	
Shale, locally ferruginous	1.0
Sandstone, grey, fine-grained, knobbly	0.6
Shale, grey	0.5
Seatearth, brownish grey	0.5
Sandstone, brown, medium- to coarse-grained, current- bedded; mainly massive but thinner bedded towards top	10.0
Section obscured	1.0
Shale, grey, with thin fossiliferous sandy limestone [0531 5924 and 0508 5846]	0.4
Sandstone, grey, fine-grained	0.25
Seatearth, greyish brown	0.5
Sandstone, brown, fine-grained, soft, with roots	1.0
Shale, grey	0.2
Limestone, grey-brown, fossiliferous (Whitehouse Limestone) [0570 5830]	0.2
Shales, grey, and sandstones, greyish brown, fine-grained	? 10.0
The marine bands of the Whitehouse Limestone and the sandy limestone about 2 m above it were not recorded in a continuous section, but occur so in Reaston Gill just west of the area. The sandy limestone probably equates with the marine band in Healey Burn. Foraminifera from the Whitehouse Limestone of the Lynn Burn are of Kinderscoutian age.	

WESTPHALIAN ROCKS

Strata up to the Ganister Clay

Westphalian strata below the Ganister Clay are predominantly arenaceous, and more like the underlying Namurian grits than the overlying Coal Measures. Coal seams, including the Ganister Clay, are generally impoverished and impersistent and have been little worked. In the southern half of the area the Ganister Clay has not been definitely identified at outcrop; its position

is inferred by reference to the Quarterburn Marine Band and younger coal seams.

Shotleyfield Burn and Small Burn. The valley sides north of Shotleyfield Burn, near Shotley Field Mill [0610 5325], exhibit marked features attributable to low Westphalian sandstones and shales. The following section occurs in Small Burn [0609 5307]:

	m
Sandstone, pale brown, coarse-grained, cross-bedded, micaceous, conglomeratic and feldspathic towards base	4.00
Seatearth-sandstone, brown, medium-grained with shaly siltstone intercalations, eroded top	1.20
Shaly siltstones, grey-brown, with thin beds of fine-grained sandstone, ripple-cross-laminated, rootlets towards top, gradational base	2.00
Shale, silty, dark grey with thin beds of fine-grained micaceous sandstone; overlies Quarterburn Marine Band exposed in Shotleyfield Burn [0624 5310] (see above)	1.50
To the south of Shotleyfield Burn, strata between the Quarterburn Marine Band and the Ganister Clay are concealed beneath thick drift deposits.	

Mere Burn and Yecklish Burn. The following strata exposed downstream from Mereburn Bridge [0859 5488] overlie the Mere Burn Namurian sequence described above:

	m
Sandstone, pale brown, coarse- to medium-grained, cross-bedded	5.00
Shale, dark grey, fissile, poorly exposed, commonly cut out by erosion surface beneath overlying sandstone	0.60
Mudstone, pale grey, with silty and carbonaceous laminae	1.50
Seatearth-sandstone, orange-brown, fine-grained, micaceous, ganisteroid at top	0.96
Interbedded sandstones, fine-grained, micaceous, flaggy with ripple marks, and silty shales	1.20
Mudstones, dark grey, ironstone nodules towards base	3.00
Shear zone, brecciated shale and clay gouge	0.10
Quarterburn Marine Band: fossiliferous sandstone post with abundant <u>Zoophycus</u>	0.20

The upper reaches of Mere Burn provide sections through younger strata, mainly medium- to coarse-grained, flaggy to cross-bedded, micaceous sandstones [0778 5445; 0720 5433; 0694 5420; 0626 5429]. Exposures of the intercalated argillaceous rocks are less common, but black micaceous shales were seen at [0698 5420].

Yecklish Burn provides the following section [0788 5480]:

	m
Shales, black fissile	1.00
Sandstone, purple, medium-grained, crudely bedded, bioturbated	0.40
Mudstone, sandy, pale grey, micaceous, gradational base	0.75
Sandstone, pale grey, medium-grained	1.15
Sandstones are extensively exposed in the upper reaches of the burn below the inferred position [0697 5492] of the Ganister Clay.	

Area east of the River Derwent. The steep valley sides common east of the River Derwent are largely free of drift, and detailed feature mapping is possible.

The following strata exposed in Snow's Green Burn upstream from Snow's Greenburn Bridge [0921 5341] overlie the Namurian rocks of this burn described above:

	m
Sandstone, pale brown, coarse-grained to conglomeratic, feldspathic, massive to cross-bedded, with ganisteroid beds	15.00
Seatearth-sandstone-mudstone, pale grey, soft, micaceous, eroded top	0.40
Sandstone post, green-brown, coarse-grained, ferruginous	0.40
Sandstone, dark grey to brown, shaly, fine-grained, micaceous, friable, with more massive beds, poorly fossiliferous	1.30
Sandstone, orange-brown, fine-grained, micaceous, ferruginous	0.10
Coal, bright	0.15
Seatearth-sandstone, yellow-grey, fine-grained, micaceous, capped by ganister (0.10 m)	0.78
Sandstone, grey-brown, medium-grained, micaceous, ripple- cross-laminated, gradational base	0.30
Cross-laminated fine-grained sandstones and siltstones with shaly beds and laminae, becoming more shaly downwards, gradational base	3.20

	m
Mudstone, silty, dark grey	1.20

The break in section beneath the bridge is the inferred position of the Quarterburn Marine Band.

Farther to the east [0970 5308] a 15-cm shaly coal exposed in a tributary of Snow's Green Burn may be the Ganister Clay.

The steep cliff sections which form the eastern bank of the River Derwent to the north and south of Westlaw Wood [096 543] are of low Westphalian sandstones. A thin coal observed at the base of the cliff [0951 5397] may equate with the unnamed seam exposed in Snow's Green Burn.

Records exist of Westphalian strata up to the Ganister Clay formerly exposed along Blackstone Burn. The stream has been culverted and its valley is now largely filled by made ground, but exposures of massive sandstone are visible at [0953 5175]. Earlier surveys also recorded a coal, presumed to be the Ganister Clay, cropping out [0907 5003] in a stream south of The Grove.

Kellas Plantation to Fairley May. On the south side of the Ninety Fathom Fault, a coal seam running east-west through the northern part of Minsteracres grounds is considered, from its relationship to younger seams to the south, to be the Ganister Clay. It was seen in the gas pipeline trench [0224 5624] to be 0.2 m thick, resting on a sandy seatearth and within a sequence mainly of shales and mudstones.

The Westphalian rocks below the Ganister Clay west of Minsteracres include three sandstone successions. Strata extending from the lowest to the middle sandstone in Healey East Burn are as follows [010 564]:

	m
Sandstone, brown, medium-grained, flaggy	3.0
Shale, grey	1.0
Sandstone, grey, rooty, on sandy seatearth	0.8
Shale, grey-brown, sandy	1.6
Shale, grey, with thin ripple-marked sandstones	5.0
Sandstone, grey-brown, fine-grained, hard	0.1
Seatearth, brown, sandy, and rooty sandstone	1.6
Sandstone, brown, medium-grained, flaggy	2.5

In Fairley Gill an argillaceous sequence above the lowest sandstone is overlain by a middle sandstone, mainly medium-grained and thick-bedded or massive but with some thinner beds, succeeded by another shaly sequence

containing a thin (0.075 m) coal [0393 5657]. The top sandstone is medium-grained and thick-bedded and overlain by the following beds in Newfield Burn [037 563]:

	m
Sandstone, brown, medium-grained	1.5
Shale, grey	3.5
Sandstone, grey-brown, silty	0.07
Shale, grey-brown, with sphaerosiderite about 1 m above base	3.5
Coal (Ganister Clay)	0.15
Seatearth, brown	1.15
Thin sandstones and shales, greyish brown	3.0
Shale, grey, rooty, on seatearth	1.0
Sandstone, grey-brown, thin-bedded	1.0
Sandstone, brown, medium- to coarse-grained, thick-bedded	2.0

Healey-Wheelbirks area. The argillaceous strata exposed in the headwaters of Healey Burn and presumed to include the Quarterburn Marine Band (see above) contain, just below overlying medium- to coarse-grained feldspathic sandstones, a thin (0.03 m) coal seam [0047 5822; 0067 5840] corresponding to that near the top of the Stocksfield Burn section given above.

Between these two localities, and on the north side of the Ninety Fathom Fault, lies an area of poorly exposed low Westphalian strata. The ground rises to High Fotherley [0200 5725], as does the succession, with alternating crops of predominantly arenaceous and predominantly argillaceous strata curving round the high ground. Sandstones underlie large areas. They are mainly fine-grained and commonly flaggy, but medium- to coarse-grained and thick-bedded towards the base of the succession, as on Eastwoodhouse Fell [003 598], and locally elsewhere [0246 5826]. Two thin coal seams, possibly the Saltwick and the Gubeon, are present. The lower one (? Saltwick) is marked by three collapsed adits and thickens from 0.03 m near Healey Hall to 0.6 m in Broomleyfell Plantation, which contains a number of trial shafts and two adits, and 0.3 to 0.6 m in the east around Fotherley Gill. The higher seam is thinner, difficult to trace and marked by few trials, but was seen in a gas pipeline trench [0244 5787; 0239 5830] near Low Fotherley as thin streaks of coal in up to 1 m of coaly shale. High Fotherley stands upon a prominent sandstone ridge.

The base of the ridge is considered, from reference to the general succession, to coincide with the horizon of the Ganister Clay, but the only

coal seen occurred as thin streaks in the gas pipeline trench [0248 5729].

Stocksfield Burn to Stocksfield. A composite section of the beds immediately overlying the Stocksfield Burn section given above is as follows:

	m
Shale)	0.45
Sandstone, soft)	0.45
Shale with coal (Ganister Clay)) Quarry [0567 5913], now	0.3
Sandstone, soft) filled and ploughed	1.5
Shale, with thin sandstones)	2.0
Shale, carbonaceous)	1.0
Sandstone, brown, fine-grained, massive, current-bedded	
[0645 5984]	8.0
Thin sandstones and shales with traces of coal	? 2.0
Shale, grey, with flaky micaceous sandstone	? 5.0
Sandstone, brown, fine-grained, flaggy)	1.2
Sandstones, grey-brown, thin, with interbedded shale)	? 2.0
Sandstone, brown, fine-grained, platy)	0.3
Shale, grey)	0.25
Sandstone, grey-brown, fine-grained)	0.5
Section obscured) Stream	? 1.5
Sandstone, brown, fine-grained, flaggy) [062 599]	1.0
Shale, grey, with sandstone, coaly traces)	0.4
Sandstone, brown, fine-grained)	0.15
Coal, locally split with sandstone intercalations)	0.15
Shale, grey)	0.5
Shales, mudstones and thin sandstones)	? 5.0

Strata above the Ganister Clay

The strata above the Ganister Clay form the lower part of the Productive Coal Measures. Rocks between the coal seams comprise interbedded sandstones, shales and mudstones, but in contrast to the underlying strata sandstones tend to be thinner, lenticular and impersistent.

Derwent Reservoir to Minsteracres. The ground rises steadily from the shore of the reservoir northwards towards the watershed between the Rivers Derwent and Tyne which runs approximately east-west along grid line 55. The coal seams Marshall Green, Victoria and Brockwell are present, in an outcrop pattern much affected by faulting.

A series of disused adits along Woodhouse Burn records former working in the Marshall Green seam, which a borehole [0023 5455] showed to be 0.40 m thick. A higher seam which crops out to the north is probably the Victoria; it has been proved in several NCB test boreholes, and at [0084 5461] was 0.36 m thick. The Brockwell seam has been extensively worked both from adit around [004 548] and by opencast operations at Barley Hill. Sandstones between the Marshall Green and Victoria seams are exposed in an old quarry near Wall House [0010 5406], and sandstones between the Victoria and Brockwell seams in another near School House [0214 5405].

Farther north, rubbly exposures in the gas pipeline trench running parallel to, and just outside, the western boundary of Minsteracres park, showed the following upward succession: Ganister Clay seam (0.2 m) [0226 5631]; shales and mudstones with scattered thin sandstones; a sequence predominantly of sandstone; shales and mudstones with coal streaks [0219 5578], probably representing the Marshall Green seam; medium-grained sandstones; shales with thin coals representing the Victoria seam [0217 5546]; and a broad crop mainly of shales, mudstones and siltstones with ferruginous nodules extending across the road that borders the park on its southern side. Farther west, in Kellas Plantation, the sandstones above the Ganister Clay seam are seen in Healey East Burn and Healey West Burn to be medium-grained, some thick-bedded and some flaggy. No trace of the Marshall Green seam was found in this locality. A small opencast working [014 555], now restored, near West Minsteracres probably marks the crop of the Top Victoria seam.

Greymare Hill and Shotley Low Quarter. Greymare Hill has been the site of extensive NCB exploration and coal extraction. Both the Ganister Clay (0.13 m) and the Marshall Green (0.5 m) seams have been proved by boreholes, but have not been worked. Higher seams ranging from the Bottom Victoria to the Top Busty once followed concentric crops around the hill, but most of the ground containing these seams has been worked out by opencast mining and is now fully restored. Old ironstone workings recorded during previous surveys [0531 5521] marked local extraction of the German Bands Ironstone which occurs impersistently immediately above the Bottom Victoria seam.

Broad interfluvial stretches eastwards across and to the south of Shotley Low Quarter. Sandstones immediately overlying the inferred crop of the Ganister Clay cap these ridges and crop out extensively. Sections occur at Pikehill Quarry [0735 5392] and at Blue House [0771 5345], where 5 m of pale brown, medium-grained, massive to cross-bedded sandstone have been recorded.

The Marshall Green seam is thought to crop out beneath the drift at Wood House [0590 5220].

Consett and Shotley Bridge. Strata beneath Consett and Shotley Bridge range from the Ganister Clay seam to the Three-Quarter. In the south the crops of seams ranging from the Marshall Green to the Three-Quarter are now largely concealed by the extensive spoil tips of the Consett Steel Works. Sandstones within the drift-free spurs which characterise the eastern side of the Derwent valley are generally lenticular and impersistent.

To the north, the Top Victoria and Bottom and Top Brockwell seams have been worked by opencast methods to the south of West Law [100 539]. Sandstones below these seams are well exposed in Snow's Green Burn [0980 5322] and its tributaries to the south [0990 5305] and in a disused quarry at Greenwood [0972 5400].

Newlands area. The following section is exposed along Mill Dene:

	m
Sandstone, brown, medium- to coarse-grained, massive [0914 5536]	3.0
Shale, grey-brown, sandy, with thin shaly sandstones	3.3
Sandstone, brown, flaggy	1.0
Shale, grey	1.3
Sandstone, medium- to coarse-grained, massive, ochreous, locally passing laterally into thinner beds	1.6
Shale, grey, with thin sandstones	2.5
Sandstone, brown, flaggy, current-bedded	3.0
Fault, trend north-west, downthrow north-east	
Shale (mainly), grey, degraded, adit and bellpit in north bank (probable position of Ganister Clay)	? 3.0
Sandstone, brown, flaggy, micaceous	0.6
Shale, grey, blocky, locally nodular	2.5
Seatearth, brown, sandy, locally ferruginous	2.0
Shale, grey-brown, sandy, micaceous, locally nodular with a few thin fine-grained sandstones (River Derwent)	5.0

It is considered that the strata above (upstream of) the fault lie beneath the Ganister Clay, whose crop probably passes between the top of the section and Newlands Bridge. Upstream of the bridge occur a few exposures of medium-grained flaggy sandstone. They underlie the Marshall Green seam which is

seen at the water's edge [0873 5563] to be 0.6 m thick.

Whittonstall area. The high ground on which Whittonstall stands constitutes another outlier of strata containing workable coal seams ranging from the Victoria to the Harvey. Most of the coal south-west of the B 6309 road has been dug out from surface workings and the ground restored, but a prominent feature trending west-south-west from Whittonstall Sproats attests the presence of a thick and persistent sandstone beneath the Brockwell seam. Sandstones higher in the sequence are discontinuous. The thickest coals, the Brockwell, Bottom Busty and Top Busty, crop out respectively as rubbly exposures in old workings [0704 5721], alongside a house in the village [0737 5706], and in a small disused quarry [0741 5702]. The area north-east of the B 6309 road has been intensively drilled down to the level of the Victoria seam.

Features parallel to the Whittonstall-Fairley road, and a few scattered exposures, suggest the presence of much sandstone and two thin coals between the Marshall Green and Victoria seams. Sandstones of variable thickness are common higher in the succession, especially between the Three-Quarter and Bottom Busty seams. Strata from the Victoria seam to the Harvey are about 70 m thick.

Hollings - Labourn's Fell area. A wooded valley running south-east from Spring House, and passing south of Hollings, bounds the Whittonstall prospect on its north-eastern side. Slopes rising north-eastward are extensively scarred by workings along the crops of the Brockwell, Three-Quarter, Bottom Busty and Top Busty seams. A section [0959 5676] at the foot of the sorting plant in Broadoak Quarry shows seatearth 0.55 m, overlain by coal (Top Brockwell) 0.75 m, shale with scattered silty nodules and plant remains 1.3 m, shale with ferruginous nodules 0.7 m, shale with thin sandstones 1 m and thick-bedded sandstone 1.5 m.

Higher in the succession the Tilley, Harvey and Ruler seams, and the Harvey Marine Band, have been proved in boreholes. The overlying strata comprise thick sandstones, apparently without any notable development of the Hutton seam. Quarries [090 587] immediately south of the Ninety Fathom Fault, near Airy Hill, show up to 6 m of massive, thick-bedded and thin-bedded sandstones, commonly micaceous and current-bedded, with a few shaly intercalations. A borehole alongside the quarries proved mainly sandstone to a depth of 28.7 m.

Hedley on the Hill area. The steep slope rising eastwards from New Ridley Road comprises three sandy gorse-covered small ridges and the complementary slacks. Probably the former are attributable to sandstones and the latter contain the horizons of the Marshall Green, Victoria, Brockwell and Three-Quarter coal seams, the top and bottom seams about 40 m apart. An adit [0715 5927] was driven in the Brockwell seam, here 1.9 m thick but split by 0.86 m of sandstone and shale.

High ground of Hedley on the Hill, and Hedley Fell to the east, are ringed by the crops of coal seams ranging from the Three-Quarter to the Durham Low Main, all cut off to the south by the Ninety Fathom Fault. Their positions on the map are based largely on borehole evidence. Exposure is poor, but mappable sandstones occur between the higher seams and sporadically elsewhere.

In Westriding Wood, adits of the only active mine in the area show the Top Busty seam 1 m thick. Rubbly exposures alongside the Hedley-Prudhoe road show traces of coal probably marking the positions of the Bottom Busty, Top Busty, Tilley and Harvey seams. The Harvey Marine Band has been proved in boreholes, but its crop is everywhere inferred. A prominent ridge above it shows exposed fine-grained platy and flaggy sandstone near Hedley on the Hill and Hedley Grange, and abundant debris elsewhere. The Durham Low Main seam is exposed [0896 5885] in the farmyard at Airy Hill, just north of the Ninety Fathom Fault, and represented in rubble from burrows [0879 5887] and bellpits [0865 5877] near by.

STRUCTURE

An easterly regional dip prevails, but so slight as commonly to be imperceptible in exposure. The course of outcrop of coal seams suggests a fall generally between 1° and 3° . Slight flexures occur locally, as where a gentle dome crossed by the Stocksfield Burn south-east of Hindley brings up Namurian strata extending down to the Whitehouse Limestone. Steeper dips affect strata in some places near faults, as shown by outcrop patterns near the Ninety Fathom Fault south of Hedley on the Hill; a north-west-trending fault exposed [0390 5621] in Backworth Letch separates horizontal strata to the north-east from beds dipping 40° SW to the south-west.

The Ninety Fathom Fault runs west-south-west from east of Hedley on the Hill to Kellas Plantation. Its (northerly) downthrow ranges from over 30 m in the east to about 11 m in Wheelbirks Woods and near Healey. Except where

bordered to the south by thick sandstones overlying the Ruler seam (see above), the Ninety Fathom Fault, in common with other faults, is usually marked by a surface depression. Splay faults from this major fracture trend west-south-west and south-west across Whittonstall Common, one of them branching beneath Greymare Hill and displacing strata by 15 - 20 m. Strata east of Whittonstall are cut by small faults coursing north-west and north-east; throws usually do not exceed 10 m.

Two important NW-SE fracture lines, both downthrowing to the north-east, cross the southern part of the area. The Healeyfield Fault runs from Wallish Walls [063 502] to Greymare Hill. Its throw, 85 m in the south, diminishes northwards and the fault is truncated by the Greymare Hill splay fault referred to above. Lead/silver mineralisation is associated with the Healeyfield Fault in the Derwent gorge immediately south of the area.

A fracture zone here termed the Muggleswick Fault was encountered during the construction of the Derwent-Wear Tunnel of the Kielder Water Scheme and equates with one proved by the Derwent Dam site investigation. A throw of 55 m was estimated in the tunnel. The fault passes north-westwards beneath the reservoir, truncating the Greymare Hill splay fault. At Bale Hill [005 535] the throw is 125 m and it may be that the Muggleswick Fault has taken up the throw of the waning Healeyfield Fault to the east. Severe distortions of dip in the vicinity of the Muggleswick Fault were noted in the Derwent-Wear Tunnel.

Joint planes are very steep or vertical, and best displayed in thick sandstones. They comprise two sets, trending approximately north or east within the ranges north-north-west/north-north-east and east-north-east/east-south-east. Two tributaries of the Stocksfield Burn near Bridges Farm [044 574] swing to northerly courses where they cut through thick sandstones; they have followed a principal joint direction and it seems likely that similar controls of drainage channels have operated elsewhere.

Most notable of the sedimentary structures are the eroded surfaces beneath many of the thick sandstones, which latter may be seen in exposure to cut out underlying beds, and the widespread current bedding, which although somewhat variable is generally indicative of a northerly source of sediment.

MINING

In the north-east of the area, underground workings (see overlay to quarter sheet NZ 05 NE) on the northern side of the Ninety Fathom Fault extend

westwards to the site of the abandoned Hedley Colliery [071 593]. The coal seams that have been worked range from the Brockwell up to the Durham Low Main. Beyond the break in workings marking the line of the fault, mining has extended south to Hollings Hill and west to Hollings and Spring House. Workings extend from the Brockwell seam up to the Harvey, above which there is much sandstone (see above).

The only active underground mining takes place at Hedley Pit, a small private mine in Westriding Wood, whose workings are currently confined to the Top Busty seam. A northern adit [0734 5857] was closed in 1981, as that part of the concession was worked out, but a southern drift [0749 5834] continues in operation.

East of Whittonstall, seams from the Brockwell to the Top Busty have been mined. South-west of the B 6309 road, subsequent opencast operations, now concluded, were carried down to the Victoria seam (Fig. 4). An application to carry out a similar programme north-east of the road, taking coal from strata extending from the Top Victoria seam to the Harvey seam, was refused; future extraction there remains possible.

At Greymare Hill, mining down to the Brockwell seam has been followed by opencast extraction of coals ranging from the Top Victoria seam to the Top Busty. Immediately to the west, the Brockwell seam has been mined underground from outcrop, the workings extending about 130 m north-south by 50 m east-west [037 554].

Surface working of the Top Victoria seam extended for about 370 m along the crop [014 555] near West Minsteracres. South of Minsteracres, at Barley Hill [024 548], the Brockwell seam has been exploited by underground and opencast mining.

On the eastern edge of the area, at West Law [100 538], the Victoria and Brockwell seams have been worked by opencast methods.

Two collapsed adits [0205 5945; 0210 5945] in Broomleyfell Plantation mark the entrance to a very small underground working of a coal, possibly the Saltwick, about 20 m above the base of the Westphalian. The seam is 0.62 m thick at the eastern adit, and workings extend south-westwards for about 200 m.

Any future large-scale extraction of coal will be by opencast mining, mainly within areas already worked underground. Proved reserves exist immediately east of Whittonstall (see above), and the same range of seams is present around Hollings and Woodhead, beyond the valley that forms the north-eastern boundary of the Whittonstall prospect.

Coal crops skirting the rise on which stands Hedley on the Hill suggest that working of seams from the Brockwell to the Harvey might be contemplated in an area stretching from Westriding Wood to Hedley Park and beyond. Higher seams (Ruler to Low Main) occur on the northern side of the Ninety Fathom Fault south-east and east of Hedley on the Hill; the Low Main locally exceeds 2 m in thickness; both it and the Hutton seams have been worked underground, but limitation of extent, the presence of thick sandstones, and the proximity of faults suggest that future working, although possible, is less likely than in the lower seams farther from the fault.

West of Greymare Hill, it appears likely that the Top Victoria seam is thin. However, the Brockwell seam may be workable east of the southern entrance to Minsteracres, and ground form suggests its possible presence between there and West Minsteracres.

The adit [0534 5958] alongside the Stocksfield Burn is driven slightly north of west in shales. It continues for 12 m to a 2-m vertical drop into a chamber 3 m across, and thence for 5 m in the original direction to where the descending roof meets the floor. The shales are locally slightly ferruginous, and contain scattered ironstone nodules, and the adit must be presumed to be a failed trial for ironstone. Farther upstream the remains of an old bloomery [0487 5797] point to early attempts at smelting.

The early growth of the iron and steel industry around Consett stemmed from the presence of local ores, including the German Bands ironstone, but no workable reserve exists.

DRIFT DEPOSITS

The high ground east of Hedley on the Hill carries little or no drift. Elsewhere, among the largest drift-free areas are the expanses of made ground resulting from restoration of opencast works around Whittonstall Sproats and Greymare Hill, the high moors north-west of Edmondbyers and the spurs below Consett on the eastern side of the River Derwent.

Most of the superficial cover is boulder clay less than 5 m thick, generally comprising variable stiff, mottled grey and ochreous sandy and stony clays. The contained stones are mainly sandstone of local derivation, but a few volcanic rocks from more distant sources are also present. No good sections exist, but some details were afforded by boreholes of the Kielder Water Scheme. A stony clay mantle east of Gallow Hill Farm [0278 5967] is rarely over 5 m thick. To the south, alongside Hindley Burn [0353 5881], it

exceeds 20 m, suggesting the presence of a buried valley. Alongside the track between Fell House and Hindley, a borehole [0373 5845] proved silty sandy clay to 1.2 m, stony clay to 5.1 m, and clayey sand passing down into sand (not bottomed) to 6 m. Still farther south, over 13 m of stony clay occur alongside the headwaters of the Stocksfield Burn [0381 5738]. A gas pipeline trench south of Gallow Hill Farm showed 1 m of poorly sorted gravel beneath 2 m of stony clay.

Glacial sand and gravel is shown (Fig. 4) covering a considerable area around Hindley [049 592], but lateral transition into sandy boulder clay is common and the boundaries are locally arbitrary. The farmer at Brookside [0421 5944] reports up to 5 m of sand beneath the field immediately east of the farmhouse. Small mounds of sand and gravel occur to the south and west, and the southernmost [042 572] has been dug for sand.

Fox Hill [070 584] is a small circular mound of sand.

Sand and gravel is extensive between Hollings Hill [097 574] and Newlands. Several small hills lie west of the main outcrop, and a disused pit [095 564] in one of them shows degraded faces of up to 10 m of sand and stony gravel. South of Hollings Hill, boreholes for coal proved up to 51.8 m of drift, probably broadly comprising sand and gravel on boulder clay. Broadoak Quarry [098 567] is being worked for sand and gravel. Faces show up to 10 m of sand and pebbly sand, locally cemented and in places current bedded.

In the south of the area sand and gravel deposits form a series of isolated masses. They consist typically of poorly sorted, medium- to coarse-grained unconsolidated sands and gravels with variable clay contents, are commonly cross bedded and locally contain discrete beds of laminated silty clay. Such deposits give rise to characteristic mounded ground, and contacts with adjacent boulder clay are usually marked by seepages or spring lines. At Edmondbyers degraded gravel pits [0115 5015] occur in a large isolated deposit of sand and gravel; sections remain unobscured at [0124 5007] and [0148 5012]. To the east more extensive deposits south of the Derwent Dam contain a small quarry [0287 5099] showing 4 to 5 m of cross-bedded sands and gravels. A borehole [0467 5004] has shown that irregular mounds at Muggleswick comprise at least 8 m of sand and gravel. Other deposits occur at Manor House [042 522], south of Greenhead [053 515] and in the vicinity of the southern portal of the Letchouse-Derwent Tunnel [044 516], where 3 to 4 m of clayey gravels and cross-bedded sands were exposed during construction.

Sand and gravel deposits form the mounds of Broom Hill [079 509] and Brown's Hill [080 515] and the ridge through Orchard Field [072 515]. Patches

of sand and gravel north of Burnhouse Gill show traces of former workings. The deposit mapped to the south of the stream above Burnmill [072 528] is very thin.

The deepest buried valley in the area is that of the River Derwent (Fig. 4); up to 90 m of drift have been proved [0558 5015] and the sequence comprises interdigitated boulder clay, sands and gravels and laminated silts and clays. The river is bordered by deposits of silt, clay, sand and gravel, mainly alluvium with tracts of first and second terrace. Control of river flow from the Derwent Reservoir has resulted in much of the old flood plain lying above the limits of normal flooding, and such areas have been mapped as part of the river terrace system. Elevated terrace features at Derwent Bridge [032 513] and Low Waskerley [086 533] are interpreted as remnants of an early post-glacial flood plain. This appears to have been cut into the boulder clay of the buried valley, and displays channel gravels and a patchy veneer of unconsolidated silts and fine-grained sands. Discontinuous strips of alluvium and terrace occur alongside many of the tributary streams which flow into the Derwent.

Lacustrine alluvium rests on boulder clay in a few small isolated hollows. Peat mantles small areas of high moorland north-west of Edmondbyers, and the presence of scarp features on this high ground has facilitated the accumulation of alluvial fan deposits. Fotherley Moss [016 575] is an area of peat of maximum extent 500 m x 300 m. Its eastern part is commonly wet, with a patchy cover of rushes; in the west thin woodland grows on drier friable peat. The thickness of peat is unknown, but is unlikely to exceed 2 m.

Extensive areas of landslip occur on the slopes of the Derwent valley west of Consett.

CONSTRUCTION AND MISCELLANEOUS MATERIALS

Small quarries, opened for use in the immediate vicinity and abandoned when sufficient stone for building or field wall had been extracted, occur sporadically within most of the thicker sandstones. Only at Airy Hill is there a quarry more than a few metres across; the workings are now much overgrown and extend for about 200 m. Nowhere in the north of the area is there a development of stone of such thickness and quality as to justify extraction in the foreseeable future - even as road aggregate.

Sand and gravel adjacent to the Marley Tile Works [092 561] are considered to be worked out. In and around Broadoak Quarry [098 567] reserves are large

in relation to the scale of operations. Elsewhere, sand and gravel too commonly grade into sandy boulder clay, or occur in too small isolated patches, to comprise economic reserves.

No clay has been worked in the area, but old maps show 'Minsteracres Tile Works' to have been situated [015 552] just west of West Minsteracres. Presumably a small local industry served the Minsteracres estate and its surrounds, using Coal Measures shales possibly near the horizon of the Brockwell seam. No similar future development is likely, and no lacustrine clays other than thin partings in glacial drift, are known.

The peats of Fotherley Moss and Edmondbyers are insufficient to constitute a useful resource.

PLANNING AND ENGINEERING

The possibility that coal seams dug underground in the past constitute reserves that will justify opencast working in the future suggests that land overlying mines in the present area should remain free from any development that might prevent such recovery of the remaining coal. Major problems of subsidence into old workings, which are mostly at fairly shallow depth, would also be avoided. Restored ground, once consolidated by time, and mechanically compacted where necessary, presents no great problems to small-scale engineering projects or the stability of small buildings.

Areas west of Greymare Hill where the Brockwell seam may be present (see above) might also merit protection until explored, but lower seams in this western part of the area do not constitute a valuable resource.

Sand and gravel around Broadoak Quarry (Fig. 4) are probably also worth preserving as available reserves, although not at great cost, since they are a poorly sorted somewhat variable mixture. An impression based entirely on the spread of old pits is that more systematic extraction and restoration should be possible if required.

Little information is available about the engineering properties of the rocks of the area. A gas pipeline trench, seen from Gallow Hill Farm to the south side of Minsteracres, showed that strata from about 17 m above the base of the Westphalian up to the Brockwell seam could be dug out to depths of four or five metres without the need of explosives.

More details are contained in a site investigation report (1975) by Messrs. Babbie Shaw and Morton about the route of a rising main of the Kielder Water Scheme from east of Gallow Hill Farm to Greymare Hill. Boulder clay

proved stiff to very stiff where clayey and compact to very dense where sandy; the underlying sandstones exhibited different degrees of weathering, the most weathered showing less resistance to penetration than did some of the glacial drift. Data on particle size distribution, plasticity, and compression, compaction and penetration tests are given in the report.

The Ninety Fathom Fault crosses the area (see above). It probably takes the form of a series of parallel and en échelon fractures occupying a fault zone. Although the ground appears stable, it would perhaps be inadvisable to site any major structure within 200 m of the line shown on the map.

The presence of slipped ground alongside the River Derwent has been mentioned above. Recent mass movement of the eastern valley slopes immediately west of the Consett spoil heaps, as shown by tilted trees and telegraph poles, may have been triggered by removal of spoil and consequent changes in water pressures within the rocks.

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- Davies, T.P., Carter, P.G., Mills, D.A.C. and West, G. 1981. Kielder aqueduct tunnels - predicted and actual geology. Transport and Road Research Laboratory Supplementary Report 676.

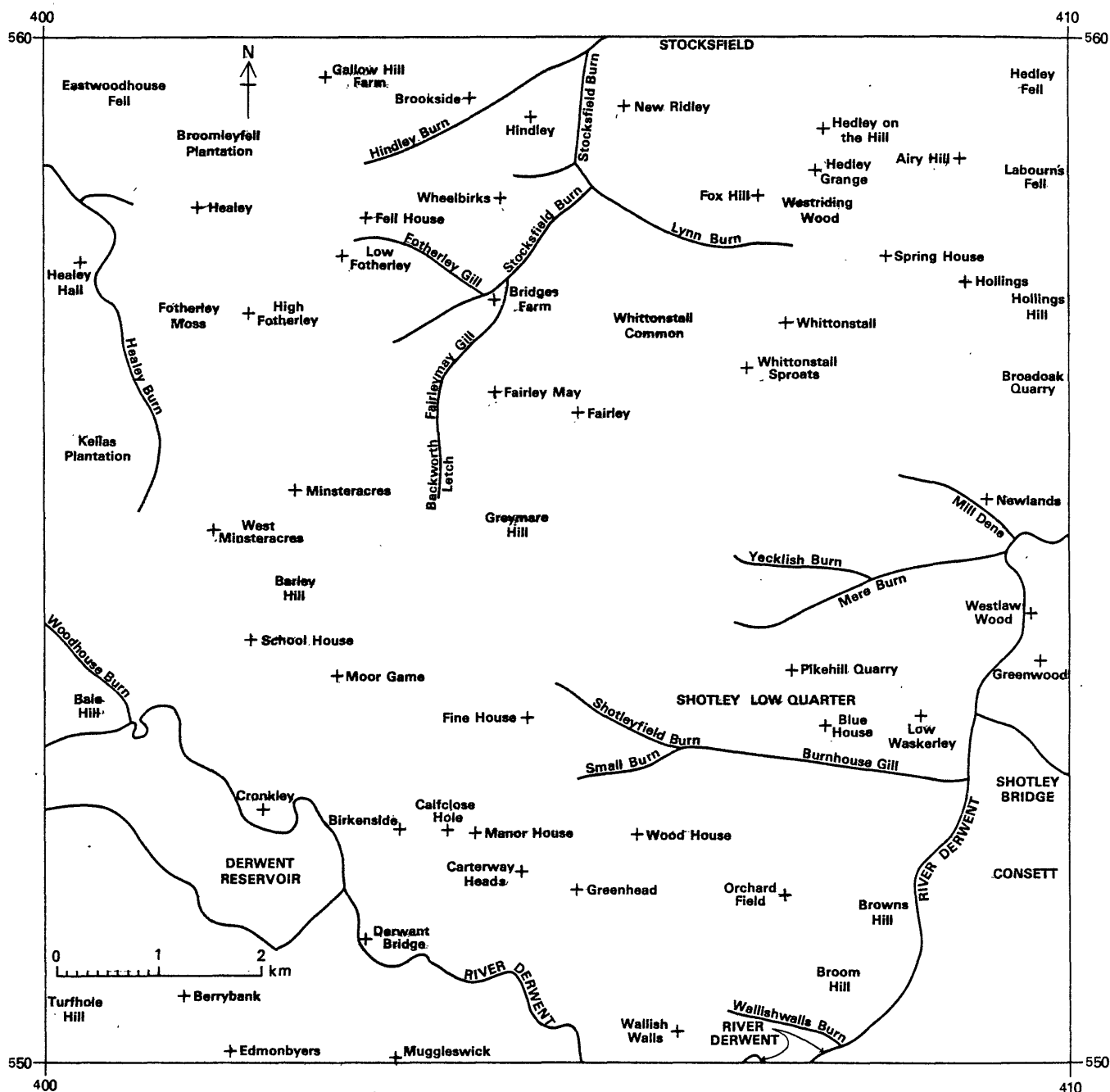


Fig. 1. Sketch map showing main localities mentioned in the text

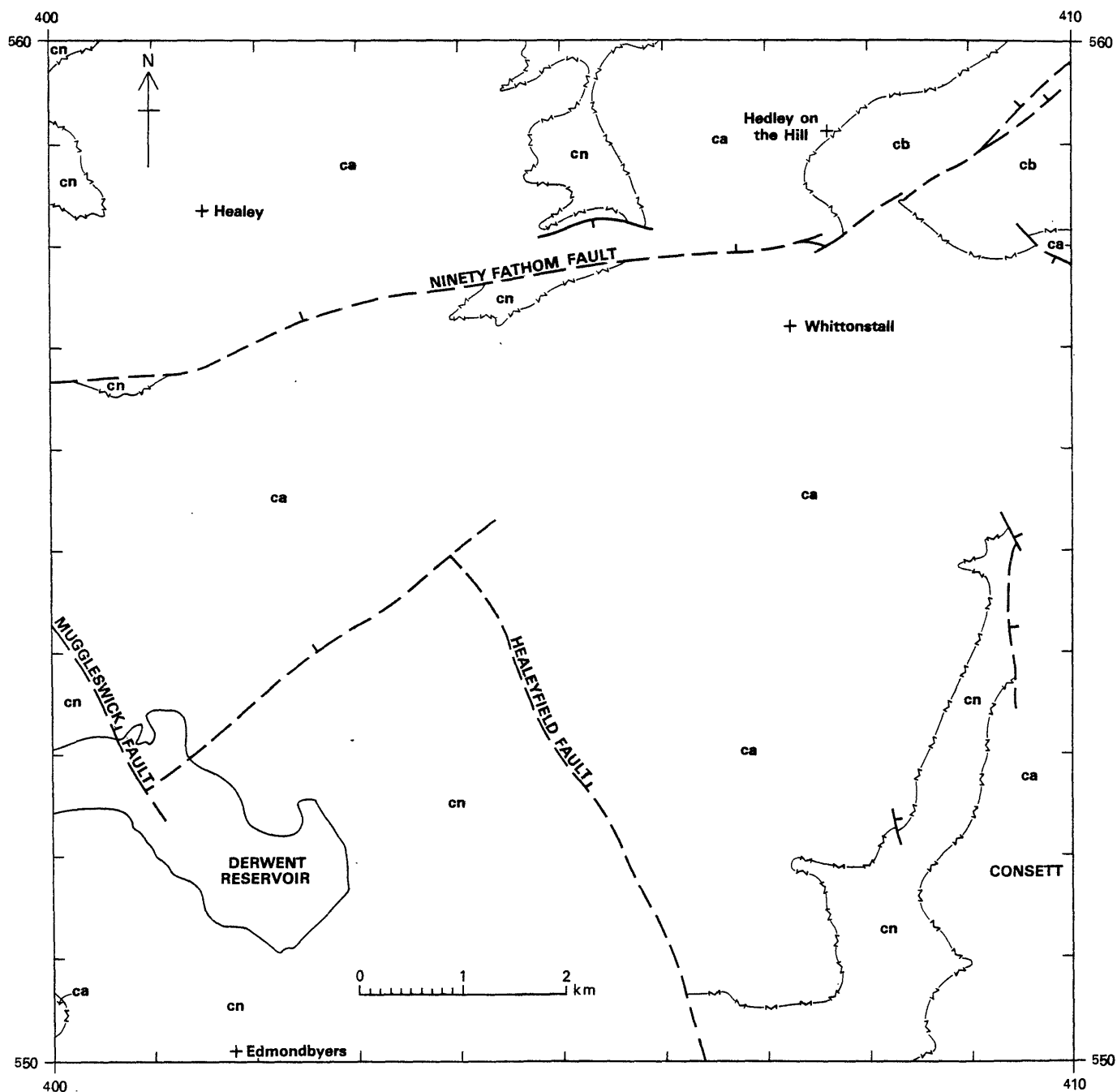
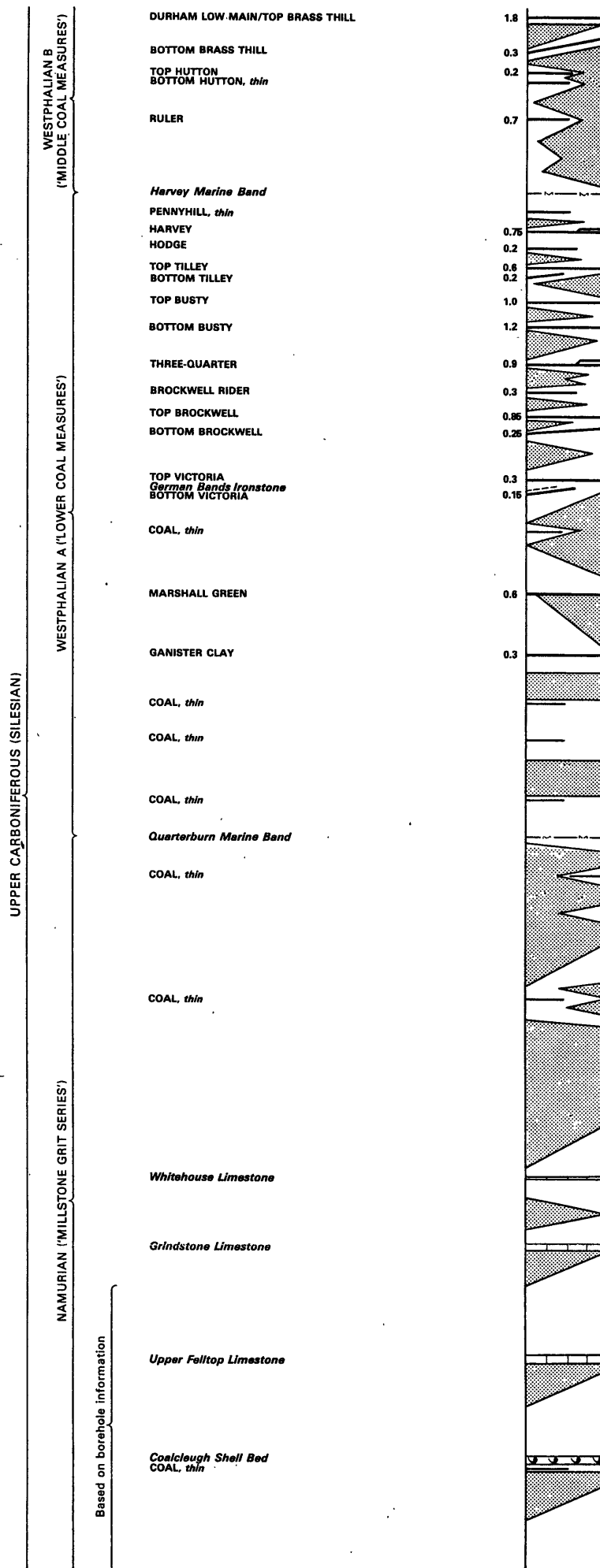


Fig. 2. Distribution of Namurian (cn), Westphalian A (ca) and Westphalian B (cb) strata

— Fault, crossmark on downthrow side
 — Marine Band



Scale 1:1000
Sandstones shown stippled
Fig. 3. Generalized vertical section of the solid rocks.

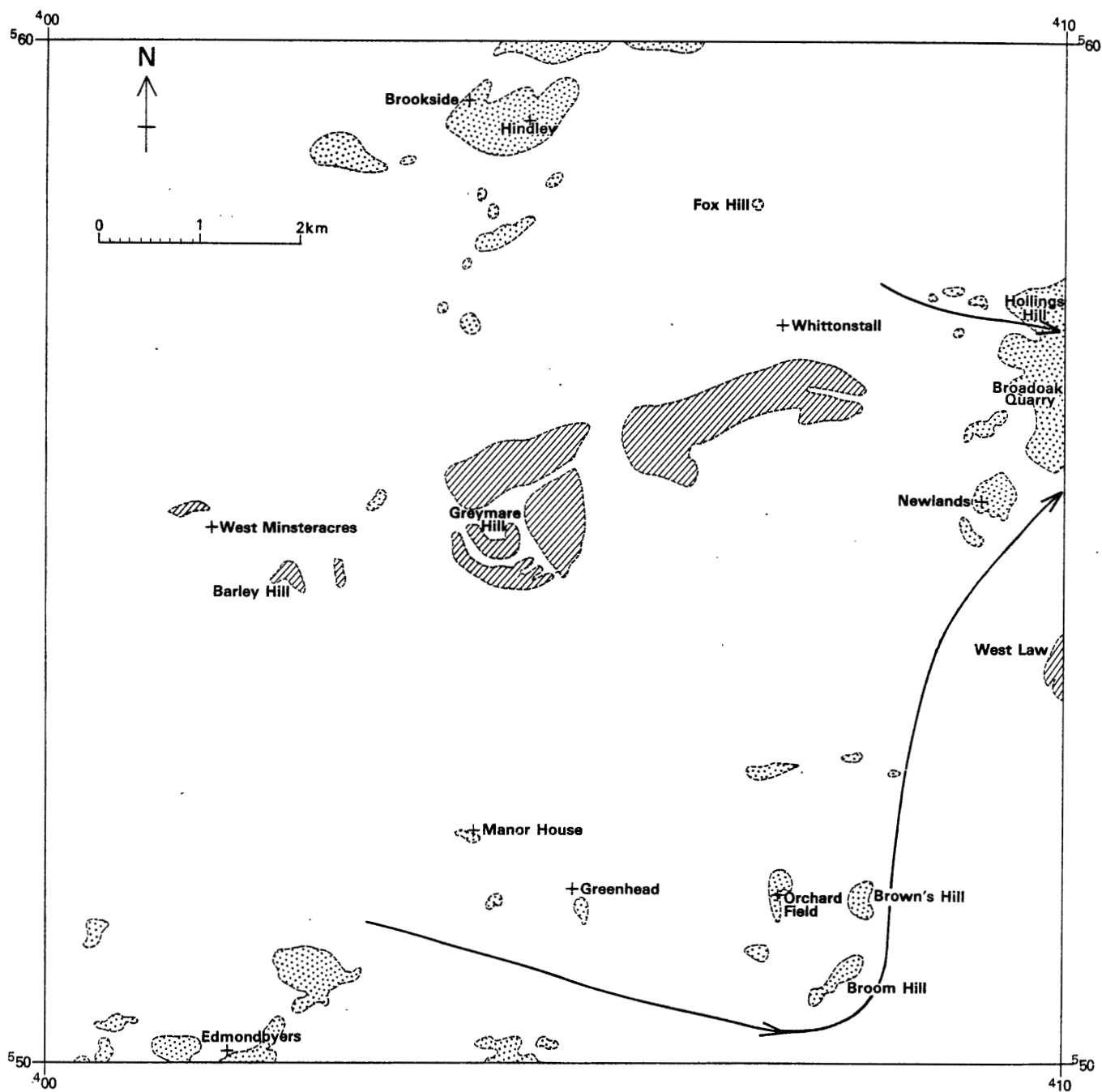


Fig. 4. Sketch map showing distribution of sand and gravel (stippled), worked out opencast coal areas (ruled) and principal buried valleys (arrowed).